A DIFFERENT APPROACH TO HAVE SCIENCE AND TECHNOLOGY STUDENT-TEACHERS GAIN VARIED METHODS IN LABORATORY APPLICATIONS: A SAMPLE OF COMPUTER ASSISTED POE APPLICATION

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ABSTRACT
The purpose of this study is to develop a new approach and assess the application for the science and technology student-teachers to gain varied laboratory methods in science and technology teaching. It is also aimed to describe the computer-assisted POE application in the subject of "Photosynthesis-Light" developed in the context of this approach choosing the most appropriate design software called "Flash Player 10.1. The study was applied during the fall semester in the 2009-2010 and 2010-2011 academic year with 188 science and technology student-teachers who attended the course of Science and Technology Laboratuvar Applications-I at the Karadeniz Technical University Fatih Faculty of Education based on action research methodology. The survey's data was analyzed with SPSS 16.00 using descriptive statistics based on mean and standard deviation. The interviewing data was analyzed according to common views. In this study, the implementation process of a developed approach was explained and an example of the computer-assisted POE application in the subject of "Photosynthesis-Light"was described. It was concluded that the developed approach introduces the science and technology student-teachers to an efficient and reflective process to gain varied methods in laboratory applications.
Keywords: Varied Laboratory Methods in Science and Technology Teaching, Science and Technology Student-teacher, Science and Technology Laboratory Application, Computer-Assisted POE Application

INTRODUCTION

The developments achieved in science and technology education within the last twenty years ha ve contributed to science and technology teaching being treated as a new field of knowledge and research (Akpınar & Bayramoğlu, 2008; Cavaş, Cavaş, Karaoğlan & Kısla, 2009; Jenkins, 2000). However, the Turkish National Education System aims at raising individuals with developed critical and creative thinking skills (Ozmen, 2004). In this process, with the agency of educational institutions, the teachers should take an active role in instructing the individuals who put forward the original, useful, new ideas and findings, and prioritize the creativeness in all areas (Cakır Ilhan, 2003; Celikten, Sanal & Yeni, 2005). Teacher efficacy is enhanced through pre-service and in-service teacher education (Stein & Wang, 1988). On the other hand, teachers' professional development cannot be described as a linear continual formulation and a defined stable process to constitute a professional perspective (Ovens, 1999; Solomon & Tresman, 1999).

It is stressed that teachers should have an approach adopting the principle of continual development during the teaching process. During effective science and technology education, the laboratory approaches that teachers apply during the teaching process require the teacher to be a guide facilitating the students to reach the knowledge rather than the presenter of the knowledge (Holt-Reynolds, 2000). However, student-teachers clarify that they do not implement profoundly the application activities because of the limitations of the process, especially regarding time (Saka, 2001). Therefore, having more practice teaching during pre-service teacher education has crucial importance to improve student-teachers' skills in relation to application of the varied laboratory methods. On the other hand, the idea of reflection and the reflective practitioner has crucial importance on raising interest in relation to elaborate practice teaching in laboratory classrooms to emerge an interactional profitable climate (Shaw, 1995). Therefore, student-teachers should be oriented to understand science and technology laboratory methods during their pre-service teacher education process.

Within the scope of science and technology laboratory applications, the aim is to develop students' skills of the scientific process by making the abstract science concepts understandable (Karamustafaoğlu, Aydın & Özmen, 2005). It is already known that this method has several positive impacts, notably: developing reasoning, critical thinking, scientific perspective, and problem solving skills in students (Feyzioğlu, Demirdağ, Ateş, Cobanoğlu & Altun, 2011; Hofstein & Naaman, 2007; Morgil, Ozyalçın Oskay, Yavuz & Arda, 2003; Usun, 2006; Yenice, 2003). Hence, laboratory applications constitute the focal point of science and technology teaching (Taşdelen, 2004). Considering this fact, student-teachers are required to make science and technology applications at the

expected level in practicing their professions. Therefore, the aim is to develop activity design and application skills toward the goals of the curriculum in the implementation of the courses that the student-teachers have taken during pre-service education process. However, although new curriculums have been developed in science and technology teaching, the disabilities in the application varied laboratory methods during teaching process can not be resolved (Saka, 2005).

The students are said to find lab activities more enjoyable and useful (Cerini, Murray & Reiss, 2003). The attention is drawn to the necessity of setting rich learning environments by the use of laboratory activities (Arı & Bayram, 2011). Although the laboratory activities in science and technology teaching have become more prominent in recent years (Thair & Treagust, 1999; Tsai, 2003; Skoumios & Passalis, 2010; Watson, Prieto & Dillon, 1995), the laboratory applications for science and technology teaching are not conducted at the desired level (Saka, 2002; Teo, 2009). The following factors are underlined as leading causes in this situation: lack of devotion and planning for laboratory applications (Backus, 2005; Booth, 2001; Hackling, Goodrum, & Rennie, 2001); teachers' negative attitudes and low-level of interest toward laboratory applications (Brown, Abell, Demir & Schmidt, 2006; Cheung, 2007); lack of efficient and sufficient course materials (Abraham, Craolice, Graves, Palmer, Aldhamash & Kihega, 1997; Lawson, 2000); overcrowded classrooms (Bayrak, Kanlı & Ingeç Kandil, 2007; Bintaş & Barut, 2008; Cheung, 2008; Hofstein, Levi-Nahum, & Shore, 2001; Kipnis & Hofstein, 2007; Prades & Espinar, 2010); students' low readiness level (Hardy, 2003); the problems related to classroom management (Jones, Gott & Jarman, 2000); lack of safety measurement in laboratories (Staer, Goodrum & Hackling, 1998); not taking students' laboratory application achievements into consideration in their assessment (Hofstein, Shore & Kipnis, 2004); and teachers' lack of sufficient knowledge and skills concerning laboratory application approaches (Furtak, 2006; Lubben & Ramsden, 1998; Roehrig & Luft, 2004; Singer, Hilton & Schweingruber, 2005). Thus, no matter how efficient a science and technology teaching curriculum is developed,or how knowledgable the teachers as the practitioners of the curriculum and as the people who will take charge in the process, the student-teachers' unawareness of their roles and responsibilities in the implementation process of the developed curriculum, and their inabilities in efficiently developing their skills of fulfilling these roles and responsibilities cause the deadlock of the encountered problems. It also necessitates the science and technology student-teachers in the pre-service education process to improve their skills by carrying out the practices enabling them to acquire knowledge about their aforesaid roles and responsibilities, and fulfill these roles and responsibilities as they are expected to do (Saka, 2007).

Teachers' inability to conduct science and technology teaching applications efficiently is explained by their inadequacy in developing their laboratory application skills (Bencze & Hodson, 1999). It will be possible for the teachers who have sufficient levels of knowledge and skills for the substantial laboratory approaches such as induction, deduction, inquiry-based approach, and constructivist approach, to choose relevant methods and techniques (Koyunlu Unlu & Dökme, 2011). Thus they will be able make the best of their time through effective planning. Then following the recovery of the commonly-encountered problems in relation with classroom management, the negative attitudes towards laboratory application will be changed. In describing teachers' competency, the ability to apply different field specific teaching methods and techniques is accepted to be one of the most important skills in terms of field teaching knowledge. However, when the sub-aspects of this skill are examined, it can be stated that teachers' skills to apply different laboratory approaches, methods, and teachniques at the desired level are materialized in three stages. At the first stage, they need to have sufficient level of knowledge about the fundamentals and principles of applying different laboratory approaches, methods, and teachniques. Secondly, they have to choose the most efficient laboratory approach, method, and teachnique specific to every subject; and next to have developed the skills to apply laboratory approach, method, and teachnique, decided to be the most effective option, at a desired level by considering the application fundamentals and principles (Bedweel, Hunt, Touzel & Wisaman, 1991). It is stressed that the teachers should carry out teaching process by using alternative laboratory approaches, methods, and teachniques complying with the students' learning styles at the upper level (Diesterhaft & Jaus, 1997).

Student-centered laboratory approaches, methods, and techniques are stated to be used at a low level or never used by the teachers in science and technology teaching (Kocaküllah & Kocaküllah, 2001; Saka, 2004a). Senior teachers, as well, do not use laboratory approaches, methods, and techniques at a desired level. Therefore, it is thought that the students' active participation is not ensured sufficiently, and the materials are not put into to their applications in science and technology teaching (Dindar and Yaman, 2002). To overcome this deficiency, the student-teachers must be trained with a perspective having them gain insight about different laboratory approaches, methods, and techniques, and put their knowledge into practice, thereby, eliminate the misconceptions. Therefore, to have the student-teachers acquire a wide range of methods, it becomes a necessity to develop and evaluate the new approaches by practicing them in order to achieve the desired efficiency in the

applications being carried out (Lunenberg & Korthagen, 2003; Saka, 2004b; Springer, Stanne & Danovan, 1999; Trumbul & Kerr, 1993).

Within the scope of the study being held, the student-teachers are provided with the alternative activity development and application opportunities thanks to employing different laboratory applications towards the same gain based on the laboratory approaches, methods, and techniques. In this context, the aim is to develop a different approach intended for promoting laboratory application skills towards science and technology teaching in the pre-service teacher education. For this reason, the student-teachers are intended to develop their skills of choosing the best laboratory approach, method, and technique for a specific subject, and obtain a wide range of methods in laboratory applications. Besides a detailed sample implementation for the computer-assisted POE application in the subject of 'Photosynthesis-Light' is presented by the student-teachers in the context of this study.

Conceptual Framework

When science and technology student-teachers interact with their peers during laboratory applications, they get experiences through collaboration for preparing their practice. Practice of collaboration could be applied by working with peers to gain varied methods in laboratory applications as a group. When the science and technology student-teachers work in groups, the method tutor's role is to orientate their interaction and intervene when necessary to contribute or support their laboratory application skills (Johnson & Johnson, 1994). In this process, working together within group and also between groups exceedingly contributes to their professional skills development by sharing their ideas, assumptions and ensuring mutual support observing each others' practice and having best relationship with peers (Talvitie, Peltokallio & Mannisto, 2000; Veenman, Bentum, Bootsma, Dieren & Kemp, 2002). It is believed that this approach is useful in constructing the framework of science and technology student-teachers' image. Because, constructing reasonable change on framework of teacher development emerges from the teacher's own practice by adaptation of others' "experimental learning" regarding agreeable features (Ovens, 1999).

Science and technology student-teachers could have an opportunity to assess their own laboratory applications' effectiveness, feeling more confident about themselves as a developing teacher and exploring new laboratory application methods. This process could have a meaningful contribution to the science and technology student-teachers regarding cooperative learning and classwide peer tutoring. It involves proactive collaborative relationships among the student-teachers which can result not only in more agreeable implementations during reflective practice of their laboratory applications in science and technology teaching, but also more beneficial examples of implemantation of student-centered laboratory application in science and technology education. Therefore, it is indicated that when student-teachers get engaged in a reflective practice with their peers, they might gain remarkable facility in the improvement of their laboratory methods in science and technology teaching (Goldstein & Lake, 2000). Observing peers' video records provides an effective reflective interaction to help and support student-teachers in relation to their implementations in laboratory applications in science and technology teaching. This interactive process has positive impact on their own laboratory applications and their skills as a team member in terms of self-esteem, encouragement and reasonable solutions.

The approach explained in this study is based on the reflections that indicate the different patterns of science and technology student-teachers' preparation for laboratory applications in the extent of supportive interaction. This approach ensures the practitioners various kinds of opportunities through reflection of specific responses, regarding learner participation, learner relationships and laboratory applications based on different approaches, methods and techniques. By this, we can prepare science and technology student-teachers for any kind of conditions especially with respect to applications for different laboratory methods. Therefore, this process gives inspiration to science and technology student-teachers for providing multiple opportunities for science and technology student-teachers to gain varied methods in science laboratory implementations.

PURPOSE OF THE STUDY

The purpose of this research is to develop and assess a new approach to the application for science and technology student-teachers to gain varied laboratory methods in science and technology teaching. It is also aimed at describing the computer-assisted POE application developed on the subject of the "Photosynthesis-Light" in the context of this approach.

METHODOLOGY

This study is implemented based on action research methodology. Since it has the characteristics concerning the development of application, the approach employed in the scope of the study requires the implementation of a "practice oriented-action research" (Holter & Schwartz-Barcott, 1993). In this process, survey and questionnaire

techniques are used. In the execution of the research, a survey and structured interview form was utilized as data collection means.

Participants

The sample consists of 188 third grade science and technology student-teachers who attended the course of Science and Technology Laboratory Application-I educated in the 2009-2010 and 2010-2011 fall education term at the Karadeniz Technical University Fatih Faculty of Education Science and Technology Teaching Programme.

Development of Measurement Tool

Before the implementation process of the approach is executed, the student-teachers were asked to state their expectations by taking the objectives of the course into account. During the execution process of the approach the student-teachers were asked to prepare a log of experience gained with the behaviors of professional skills. The items are formed with the expressions of expectations before the application and learned behaviors about the implementation process are arranged by the frequency of expression of public opinions. The developed survey was applied to 45 student-teachers in the scope of the pilot study and reliability analysis were implemented in SPSS 16.00 program. In this analysis, 95% confidence interval, taken, and discriminant validity of the survey consists of 19 items by subtracting non-distinctive 4 items was calculated as Cronbach's alpha value of 0.93. The alpha value which is greater than 0.70 shows the reliability of survey (Tavsancıl, 2002). A likert style 5-rating measurement was used in the developed survey (totally: 5, greatly: 4, partly: 3, few: 2, any: 1). This survey was used as a measurement tool to determine the level of skills acquired before the application and professional skills acquired in the process of teaching of the course based on the approach applied in Science and Technology Laboratory Application-I course. However, student-teachers in the sample assessed the processed application in terms of the level of impacts of the different laboratory approaches, methods and techniques on the development of application skills. In this process, on one hand, within the scope of the approach a laboratory scale approach, methods and techniques used by the student-teachers were put in an order and on the other hand, before and after application of the likert style 5-rated measure of opinions about the level of implementation (complete: 5, to a large extent: 4, partly: 3, very little: 2, any: 1) was used.

Data Analysis

Obtained survey data was analyzed on the basis of the mean and standard deviation with descriptive statistical methods using SPSS 16.00 package program. Interview data was analyzed on the basis of the student-teachers' common opinions about the application being implemented on the processes before and after the application of the developed approach.

Developed Approach and Implementation Process

Within the scope of the approach developed in the study, student-teachers were grouped and they carried out various applications based on different laboratory aproaches, methods and tecqniques considering that they have the same gains. The efficiency and applicability level of the applications in this process was observed and it was aimed that the students teachers skills in terms of various laboratory methods should be developed. Science and technology student-teachers in this process, have designed approaches, demonstration methods, 5E model, the POE method, worksheets, simple teaching tools and computer-assisted experiment activities on the basis of induction, deduction, and research. Thus, it is argued that science and technology student-teachers would gain a wealth of method and techniques in science and technology laboratory applications.

In the first phase of the study, a survey developed to determine their views about the level of effectiveness of the approach, was applied to 188 student-teachers in the sample during the processes, before, and after the Science and Technology Laboratory Application-I course. In the second stage, before and after the application of the developed approach, the student-teachers were asked to mark the chart prepared by considering the levels of the student-teachers' ability to apply the methods of laboratory applications related to science and technology teaching. In the third phase, student-teachers were asked to state their opinions in written format about the approach applied to the extend of "positive aspects", "negative aspects" and "suggestions for better application".

The following steps were followed in the process of implementation of this approach:

- The instructor conducting the course used the first 4 weeks of the theoretical and practical part of the course in order to make the necessary explanations about the laboratory methods to develop the student-teachers' skills to gain a wealth of methods in laboratory applications.
- In this process, the principles of application of laboratory methods, advantages and weaknesses were pointed out.

- After the required disclosures were completed in theoretical and practical courses in the first four weeks of the period, all the lessons were used as the application process.
- In the application part of Science and Technology Laboratory Aplication-I course; gains in Science and Technology Curriculum (2-3 gain) were given to the student-teachers in the extend of grade level-unit-subject-gain with 3 members in groups consecutively.
- Each of the group members made an application in the classroom in 20-25 minute periods by selecting different laboratory methods appropriate to the same gains. Student-teachers carried out their applications according to their detailed activity plans they prepared.
- Each of the group members presented the principles of laboratory methods and the reasons for choosing this method in the first 5 minutes of the incipient process of applications in the laboratory.
- Student-teachers in their presentations in this process used overhead projectors or projection devices by preparing a one-page word document in the computer environment and transferring this into acetate.
- The student-teachers watched the video recordings of the sample applications they made intending to the application of laboratory methods and techniques in attempt to increase the quality level of the applications. were attempted to increased by having.
- Sample plans were shown on the screen by a projection device transferred from the computer in order to ensure the preparation of the activity plans for the application of laboratory methods and techniques.
- After the application of each group, the application level and effectiveness of the chosen method, the observer position in the laboratory before the group elements and their peers were evaluated by the instructor.
- In the assessment, the group's gains and the laboratory method chosen by each group member were discussed in terms of "gains-method compliance". Thus, after the application of each group, the most effective laboratory method for the group gains were selected on the basis of the discussions held.
- Student-teachers were informed about the criteria used to assess the applications carried out by the student-teachers by the instructor. This observation scale was created by integrating the principles of the approach with the criteria in Teaching Practice Assessment Form, (Appendix Table 1). In the use of this form, the criteria contained in Teaching Practice Assessment Form (YÖK,1998) were considered as; Deficient (D=2 point), Acceptable (A=3 point), Well-trained (W=5 point).
- In this form of the assessment, the size of the presentation was considered 60% of the level, and the size of the plan was considered 40% of the level.
- Activity plans prepared by the student-teachers of their choice and application of the principles of the method steps of the laboratory were asked to indicate in the box to italic. Principles stated in this case contribute to increase the consistency level of the chosen method with the activity plans the student-teachers prepared.
- The course instructor in the position of the researcher, informed the student-teachers during the process of the application in order to ensure they reflected the different aspects of the teaching skills in a detailed and consistent way. At this stage, care was taken to ensure the active participation of students. In this process, the researcher often assumed a leading role.

Development Stages of the Computer-Assisted POE Application

To use the software included in the study design, the "Flash Player 10.1" software was preferred because of features such as standardized file structure, the fast, small footprint files, interaction functions and ease of use.

In the process of developing Application in Computer-Assisted POE, the following steps were conducted by the student-teachers;

- By researching literature about computer-assisted education, POE method and laboratory applications on science and technology teaching, current studies, and developed teaching materials.
- A variety of textbooks appropriate to the curriculum were used in the process of the development of activities by considering the gains as a result of the groupings made in the process of the application of the course.
- Features of an appropriate and effective interface in terms of visual design were determined.
- As an animation and design program for the objective of the research "Flash Player 10.1" were selected and the required animations, steps, texts, images and shapes were designed for the packet program to be prepared.
- Interface was prepared on "Flash Player 10.1" program and texts were placed into the interface.
- The colors shown in the material were matched.
- To ensure the widespread use of these materials academic support was provided to the student-teacher by the researcher. In this process, developed materials, available in different languages (English and Turkish) were prepared. In order to increase the level of common impact of the materials presented within this research, the form prepared in the English language was given (Appendix Figure 1-9).
- Buttons required to ensure the interactive use of the execution process of the activity were prepared and the action commands were prepared and activated;

To reflect the execution process of the activity - *Play* (►),

To stop the execution process of activity - *Pause* (II)

To replay the execution process of activity - *Replay* ()
To reflect the POE phases in the material – *POE's phases*
To watch the related animation after the explanation with POE's phases – *Continue* (>)
To reflect the instructions in the execution process of the experiment activity – *Next instruction*
To close the animation – *Close the animation* (X)
In addition, the meanings of the relevant icons were included on the icons in the screen display of the activity.
The activity material was put into the final form by taking the recommendations of the instructor and making the necessary corrections (Sample screenshots of the experiment area relevant to the developed material are given in Appendix Figure 1-9).

FINDINGS
The data obtained from the survey and the interviews conducted in the scope of the study were arranged and presented in accordance with the aim of the research as follows.

Survey Findings
As a result of the survey conducted to determine the science and technology student-teachers' views on the approach developed within the scope of the research, the teachers' gains concerning pre and post application process especially concentrated on the following skills based on the aim of the study: explaining the advantages and limitations related to the approaches, methods, and techniques by observing the applications of the activities developed for different laboratory approaches intended for the same gains (2.69-4.14); observing whether the methods recover each other's defects by using the same gains together in the context of different laboratory approaches (2.52-3.92); observing the contributions of applying different laboratory approaches, methods, and techniques to building a sufficient interaction with students in the execution of laboratory applications (2.76-4.03); developing skills related to the scientific process (2.55-3.81), setting an effective learning-teaching environment by considering different approaches, methods, and techniques in science and technology laboratory applications (2.71-3.94), preparing and applying a testing apparatus based on different laboratory approaches, methods, and techniques considering the same gains (2.71-4.01), develoing and using simple tools and equipment (2.87-4.11), reinforcing the fundamentals and application principles of different laboratory approaches, methods, and techniques (2.62-3.93), choosing efficient laboratory approaches, methods, and techniques for the same gains (2.72-3.95), developing activities pertinent to different laboratory approaches, methods, and techniques considering the same gains (2.59-3.82) (Appendix Table 2).

The considerations of the student-teachers in the sample, in terms of effect level of the conducted application on the development of applying their skills to different laboratory approaches, methods, and techniques in the pre and post implementation processes, were organized and graphed (Figure 1).

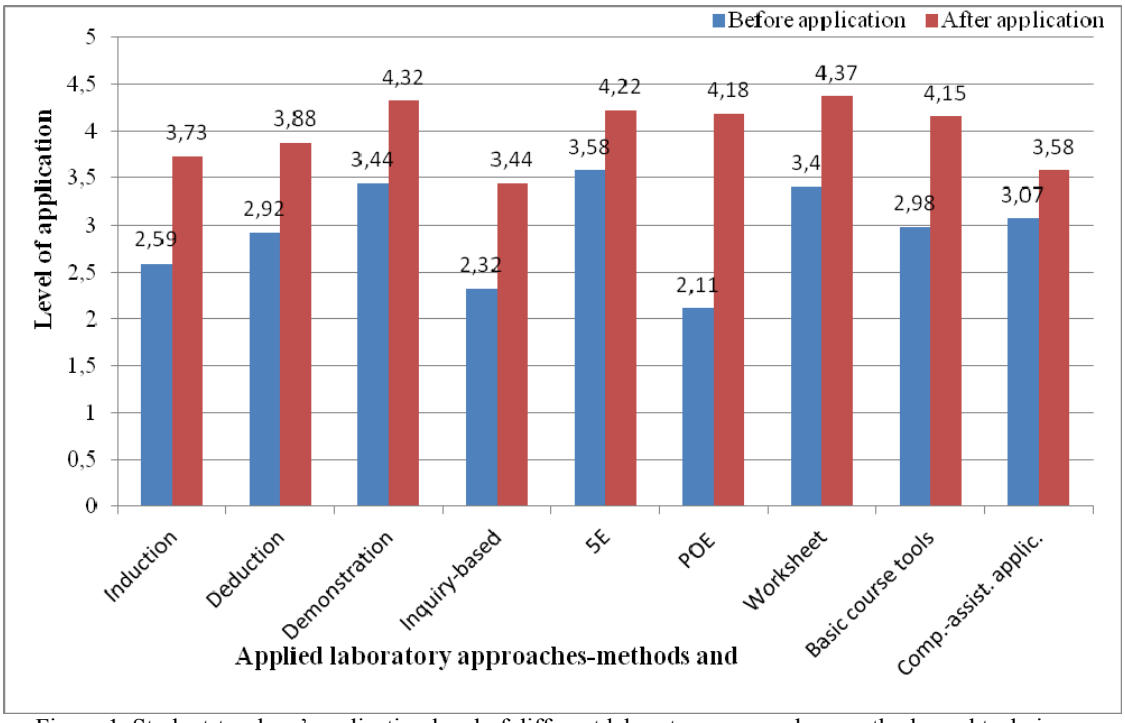


Figure 1. Student-teachers' application level of different laboratory approaches, methods, and techniques concerning the pre and post aplication processes of the developed approach.

In the context of the implemented approach, science and technology student-teachers' development at the highest level is in POE (2.11-4.18), basic course tools (2.98-4.15), and an induction approach (2.59-3.73); while their development at the lowest level is in computer assisted application (3.07-3.58), 5E (3.58-4.22), and demonstration (3.44-4.32) methods in turns. Also, the highest average values at the end of the application belong to worksheet (4.37), demonstration (4.32), and 5E model (4.22) (Figure 1).

Questionarrie Findings

The views of 45 student-teachers about the conducted application, chosen randomly from the sample, were organized by catgorizing them under three titles: "possitive aspects", "negative aspects", and "suggestions for improving the quality of the conducted application".

Positive Aspects

Taking an active role in the application of the course,
Following the choice of method, carriying out the application eagerly and in a motivated manner,
Gaining the skills toward developing and applying alternative laboratory approaches, methods, and techniques,
Developing the skill to choose the best laboratory approach, method, and technique for the subject,
Gaining the ability to evaluate for efficient use of laboratory approaches, methods, and techniques by observing the applications different laboratory methods for the same gains,
Possesing the skill to conduct laboratory applications through a method in an orderly way,
Reinforcing the attention to the course and learning the laboratory methods and techniques more effectively by taking an active role,
Enhancing the interaction level by group work,
Probing the methods to be implemented at an upper level following the improvement of interaction level,
Developing the skill to write a qualified activity report according with laboratory methods and techniques,
Understanding the advantages and disadvandages of laboratory methods and techniques in detail,
Using the limited time period in the apllication efficienly,
Gaining experience toward providing students' active participation,
Enhancing the quality level of the subsequent applications by considering the constructive criticism about the applications,
Developing the ability to explain,
The fact that experiencing an enjoyable student centered application process saves the course from being monotonous,

The fact that the effect level of visual and three-dimensional means realizes a retentive learning,
Improving self-confidence by justifying the presented information,
Building a positive competitive environment by referring to investigation,
Obtaining the opportunity to think broadly by participating in an application that include detailed student-centered roles and responsibilities for the first time,
Featuring and observing the theroretical knowledge about the methods and techniques in the process of implementation, gaining personal experience, and securing the removal of bias against the course,
Formulating its original teaching style since it enables teaching practice,
Perceiving the significance of activiating students,
Having experience about the positive effects of computer-assisted applications,
Developing their own applications by observing the applications of the chosen laboratory methods and techniques,
Gaining the skill to use everyday tools and equipment as material,
Perceiving the importance of conducting similar students-centered applications in the process of performing their profession.

Negative Aspects

Boundedness of activity application time with 20 minutes,
Observing the fact that not all subjects can be presented by means of all the laboratory methods and techniques since some subjects take longer time,
The existance of a boring application when the appropriate laboratory method and technique can not be chosen,
Teacher's being more active than students in some methods,
The lack of the opportunity to have different applications of the methods and techniques these are suitable for the gains.

Suggestions for improving the quality of the conducted application

In order to carry out the application more efficiently and realistic, an application with the students in a real classroom environment at the chosen schools can be conducted.
The students' insufficiencies can be explained through one to one interactions instead of motivating and criticising them by grades.
More opportunities toward different laboratory methods and techniques can be provided by increasing the weekly course hours.
More experience in the execution of the laboratory approaches, methods, and techniques can be secured before teaching practice.
Much time can be allocated since the application period is limited.
To conduct these kinds of courses which are student centered, the applications having similar qualifications must be carried out starting from first year of the university.

DISCUSSION AND CONCLUSIONS

While science and technology student-teachers were developing activity plans based on the different laboratory approaches, methods, and teachniques in the implementation process of the devloped application within the study, they had discussions among themselves based on causal relationships. It was asserted that these discussions would contribute to the development of their professional skills for the principles and application of the different laboratory approaches, methods, and teachniques that could be employed in the process of science and technology teaching. In this regard, the student-teachers stated, in terms of the positive aspects, in the interviews that the approach employed in the scope of the study enabled them, especially, to have knowledge about the different laboratory approaches, methods, and teachniques; be able to choose and evaluate the best ones for the subject; and gain skills to develop and apply activities considering the chosen method. Also, they remarked that the implementation process was an enjoyable application that included detailed student-centered roles and responsibilities; and that they had perceived the significance of conducting similar student-centered applications in the process of their professional practice. It is indicated that student-teachers' gaining experience in the applications of laboratory approaches, methods, and techniques by executing science and technology laboratory applications based on the student-centered approaches in the pre-service education contributed to the student-teacher's skills development in this field (Morrisey, 1981). In addition, the application of different teaching methods in science and technology teaching is attached great importance to most teacher education training curriculum (Palmer, 1992). In the context of the developed approach, student-teachers take part in classroom teaching activities based on different laboratory approaches, methods, and techniques by taking the same gains into consideration in the pre-service education process. In this process, it is claimed that student-teacher's observing their teaching skills toward their own laboratory applications in other student-teachers provides them with an evaluation process that facilitates their professional skills development and enhances their

potential of reasoning (Saka, 2005). This applied approach was concluded to enable the student-teachers to explain the advantages and limitations of the activity applications toward different laboratory approaches for the same gains; use the methods together to compansate for the defects of every method; build a qualifed interaction; develop scientific process skills; construct efficient learning-teaching setting; prepare and apply a differenciated testing apparatus; develop and apply simple course tools and equipment; reinforce the fundamentals and application principles of different laboratory approaches, methods, and techniques; choose an efficient laboratory approach; and develop skill for designing activity (Appendix Table 2). This research has revealed that the reflective process provides practitioners with different kinds of dimensions to understand the sophisticated aspects of different methods in laboratory application for science and technology teaching.

In the interviews conducted in the context of the study, the science and technology student-teachers also emphasized that the application conducted saved the course from being monotonous, built a positive competitive environment by referring to investigation, and formulated their original teaching style by enabling teaching practice. Accordingly, it was underlined that when student-centered laboratory applications were conducted, the student-teachers would not have difficulty in structuring their teaching styles and building classroom rules in the teaching process (Wubbels & Korthagen, 1990). Also, in the scope of the applied approach, the student-teachers achieved the highest level of development in POE, basic course tools, and induction approaches respectively (Figure 1). The possible reason for this is thought to be the fact that the student-teachers gained insights in the POE application in the previous term; and that compared to the other methods, they had higher level of interest in the use of basic tools. The evaluations based on the examinations conducted at the end of laboratory applications by student-teachers' trainers and all the practitioners, and discovering and sharing the experience reflect the gains of applications carried our in the context of different laboratory approaches, methods, and techniques. In this regard, attention was called upon the fact that the execution of science and technology teaching based on different laboratory methods differenciated teaching through enhancing student-teachers' skills of learning and teaching science, and their motivation (Lunenberg & Korthagen, 2003; Moshe & Pinchas, 1991). This process provides the student-teachers with the opportunity to understand and question the active and efficient experiences, with an environment for collective learning taking advantage of the developed activities. Thus, the need for building learning environments that would give the students teachers the opportunity to examine their personal theories and ideas in the context of teacher training curriculums was stressed (Wideen, Mayer-Smith & Moon, 1998). The studies underlined that teachers' doing observation in the process of education is the most effective method in changing their approaches (Dindar ve Yaman, 2002).

In the study, the student-teachers also found the opportunity to identify their problems with laboratory applications. Therefore, they will have the chance to overcome the inabilities in applying different laboratory methods in practice. In this process, they are expected to think over their inabilities, and make their own decisions to overcome these insufficiencies. Hence, this process can be considered a vital part of their professional development. Accordingly, the developed approach introduces the science and technology student-teachers to an efficient and a reflective process to gain varied methods in laboratory applications. On the other hand, the process gives them the opportunity to conduct prepatory activities and plans related to their laboratory teaching experiences that will soon take place. For this reason, this process is stressed to provide all the student-teachers with indirect experiences to display and discuss their science and technology teaching experiences, and share each other's experiences by working in collaboration (Saka, 2004b). Also, it is thought that the interaction and shared experiences and the reinforcement of communication among the science and technology student-teachers will promote the academic success in the teaching process. With this regard, the diversity of methods in laboratory applications is stated to facilitate students' success as well as increasing the teaching quality (Büyükkurt, 1998). Therefore, it is indicated that peer teaching in faculty as an intensive early field experience in the preparation of pre-service teacher education contribute to improve the ability of science and technology student-teachers in relation to reflection on laboratory applications (Metcall, Ronen-Hammer & Kahlich, 1996).

In the interviews conducted as a part of the study, the student-teachers remarked that they acquired experience with the positive effects of computer-assisted applications, and that they developed their skills of using simple tools and equipment in everyday life as course materials. However, the student-teachers achieved the lowest level of development in computer assisted application, 5E, and demonstration methods (Figure 1). This situation can be explained with the fact that science and technology student-teachers conducted the computer-assisted applications based on their individual skills without taking theoretical courses at a sufficient level. Furthermore, it can be evaluated as a result of their having newly perceived the effects of such kinds of practices in the laboratory applications after observing computer-assisted POE applications. POE applications, when conducted with computer assistance, goes well with the constructivist learning approach since it is easily possible to support students in building social communication and to obtain the reflections of their personal views. Carrying out the POE application in the computer environment enables the students to control the process. It also provides the

teachers with the opportunity of more communication in revealing students' views and thoughts (Choo, Eshaq, Samsudin & Guru, 2009; Kearneyl, Treagust, Yeo & Zadnik, 2001). It was concluded that student-teachers believed that compared to the other teachers, they would be able to apply worksheet preparation, demonstration method, and 5E model more effectively (Figure 1) at the end of the application implemented in the study since they thought that they had learn worksheet preparation at the Instruction Technology and Material Design course, and that worksheet preparation required more extensive technical knowledge and skills when compared to computer-assisted applications. The reason the student-teachers developed their ability at higher level relatively can be given to the fact that they had practice in 5E applications previously. The high level of for the use of demonstration method is thought to be caused by its practicality and easiness in application.

As for the negative aspects of the applications mentioned by the student-teachers in the interview, especially, the following points were indicated: boundedness of activity application time with 20-25 minutes, the existance of a boring application when the appropriate laboratory method and technique can not be chosen, the lack of the opportunity to have different applications of the methods and techniques, which are suitable for the gains. On the other hand, as suggestions for improving the quality of the conducted application, the attention was, in particular, attracted on the following points: conducting an application with the students in a real classroom environment at the chosen schools in order to carry out the application more efficiently and realistically, providing more opportunities toward different laboratory methods and techniques by increasing the weekly course hours, securing more experience in the execution of the laboratory approaches, methods, and techniques before teaching practice, and carrying out the applications having similar qualifications to conduct these kinds of courses which are student centered, starting from the first year of university. When science and technology student-teachers have longer periods of practical experience or more essential experience practice in laboratory teaching, this ensures they will be in a better position for adapting their experiences to practical tasks (Tillema, 2000). In addition to these, it is concluded that science and technology student-teachers would practice laboratory teaching in advance of actual practice in schools to take part in the laboratory courses in front of their peers during pre-service teacher education. So, the identified limitations could be minimised to a reasonable degree by recognising and inquiring after a lack of experiences and science and technology student-teachers will gain conscious by applying this approach. Thus, when science and technology student-teachers engage in self directed laboratory applications, their peers could improve their invaluable thoughts through reflections (Tillema, 2000).

SUGGESTIONS

In the process of pre-service teacher education, by giving priority to different laboratory approaches, methods, and techniques in application of courses concerning science and technology teaching, the instructors must aim at developing student-teacher's skills in this field at the expected level through ensuring they gain sufficient experiences. With similar approaches to be developed, the skills to apply different approaches, methods, and techniques must be developed in process of pre-service teacher education for the science and technology student-teachers starting from the first year of the university, and during in-service process for the teachers, carried on throughout their professional careers. In this context, in order to provide the student-teachers in pre-service teacher education, and the teachers, carrying out their profession at present with the the abilities to develop computer-assisted activities, the enhancement of their skills to design animation activites for science and technology teaching, through Flash program, in particular must be attributed great importance.

The development of student-teachers' skills to gain method diversity in laboratory applications for science and technology teaching must be facilitated at the desired level through some arrangements. For this aim, the student-teachers must be given greater opportunities in different courses during pre-service teacher education in order help them to practice more approaches, methods, and techniques suitable for the gains in the science and technology curriculum. In this way, the goal must be to have science and technology student-teachers gain method diversity out of different laboratory applications before they professionally take part in teaching practices. This approach reveals the need for further research in a number of areas which are related to the impact of practitioners on how many skills related to laboratory applications can be gained among varying approaches, methods and techniques to improve their own professional skills throughout their laboratory applications. One of the main implications of this research for future research would be to find out how this approach works as a framework for student-teachers' continuing improvement.

REFERENCES

Abraham, M. R., Craolice, M. S., Graves, A., Palmer, A., Aldhamash, A. H. & Kihega, J. G. (1997). The nature and state of general chemistry laboratory courses offered by colleges and universities in the united states. *Journal of Chemical Education, 74* (5), 591 -598.

Akpınar, Y. & Bayramoğlu, Y. (2008). Promoting Teachers' Possitive Attitude Towards Web Use: A Study in WEB Site Development. *The Turkish Online Journal of Educational Technology*, 7(3), 2, 46-55.

Arı, E. & Bayram, H. (2011). Yapılandırmacı Yaklaşım ve Öğrenme Stillerinin Laboratuvar Uygulamalarında Başarı ve Bilimsel Süreç Becerileri Üzerine Etkisi, *İlköğretim Online*, *10*(1), 311-324.

Backus, L. (2005). A year without procedures. *The Science Teacher, 72*(7), 54-58.

Bayrak, B., Kanlı, U. & Ingeç Kandil, Ş. (2007). To Compare The Effects Of Computer Based Learning and The Laboratory Based Learning on Students' Achievement Regarding Electric Circuits. *The Turkish Online Journal of Educational Technology*, 6(1), 2, 15-24.

Bedwell, E.L., Hunt, H.G., Touzel, J.T. & Wisaman, G.D. (1991). *Effective teaching, preparation and implementation*, Illinois, U.S.A.

Bencze, L. & Hodson, D. (1999). Changing practice by changing practice: toward more authentic science and science curriculum development. *Journal of Research in Science Teaching*, *36*, 521-539.

Bintaş, J. & Barut, A. (2008). The Effect of Classic and Web Based Educational Application, Applied for Turbo Pascal Lesson, on Student Success Level. *The Turkish Online Journal of Educational Technology*, 7(4), 92-99.

Booth, G. (2001). Is inquiry the answer? *Science Teacher, 68*(7), 57-59.

Brown, P. L., Abell, S. K., Demir, A. & Schmidt, F. J. (2006). College science teachers' views of classroom inquiry. *Science Education, 90,* 784-802.

Büyükkurt, G.B. (1998). Yöntem Farklılığının Erişiye Etkisi, Hacettepe Üniversitesi, Yayınlanmamış Doktora Tezi,
Ankara.

Cakır Ilhan, A. (2003). Sınıf öğretmeni yetiştirme programları ve sanat eğitimi. *Ankara Üniversitesi Eğitim Bilimleri*
Fakültesi Dergisi, 36(1-2), 13-23.

Cavaş, B., Cavaş, P., Karaoğlan, B. & Kısla, T.(2009). A Study on Science Teachers' Attitudes Toward Information and Communicatıon Technologies in Education. The Turkish Online Journal of Educational Technology, 8(2), 20-32.

Celikten, M., Şanal, M. & Yeni, Y. (2005). Öğretmenlik mesleği ve özellikleri. *Erciyes Üniversitesi Sosyal Bilimler*
Enstitüsü Dergisi, *19*, 207-237.

Cerini, B., Murray, I., and M. Reiss (2003). Student review of the science curriculum. Major findings. London: Planet Science, Institute of Education University of London, Science Museum in Skoumios, M. & Passalis, N. (2010). Chemistry Laboratory Activities: The Link between Practice and Theory. *The International Journal of Learning*, *17*(6), 102-114.

Cheung, D. (2007). Facilitating chemistry teachers to implement inquiry-based laboratory work. *International Journal of Science and Mathematics Education, 6*(1), 107-130.

Cheung, H.Y. (2008). Teacher efficacy: A comparative study of Hongkong and Shanghai primary in-service teachers. *The Australian Educational Researcher*, *35*(1), 103-123.

Choo, K.A., Eshaq, A.R.M., Samsudin, K.A. & Guru, B.K. (2009). An Evolution of a Constructivist Online Collaborative Learning Activity: A Case Study on Geometry. *The Turkish Online Journal of Educational Technology*, 8(1), 15-25.

Diesterhaft M.& Jaus H. (1997). The teaching of living skills in biology science: curriculum reform for the 21st century. *Contemporary Education*, 68, 3.

Dindar, H. ve Yaman, S. (2002). Öğretmenlerin ilköğretim 4. ve 5. sınıflarda fen bilgisi dersinde öğretim yöntemlerini kullanma durumları. *Kastamonu Eğitim Fakültesi Dergisi*, 103-109.

Feyzioğlu, B., Demirdağ, B., Ateş, A., Çobanoğlu, İ. & Altun, E. (2011). Chemistry Teachers' Perceptions on Laboratory Applications: Izmir Sample. *Kuram ve Uygulamada Eğitim Bilimleri • Educational Sciences: Theory & Practice,11*(2), Spring, 1024-1029.

Furtak, E. M. (2006). The problem with answers: An exploration of guided scientific inquiry teaching. *Science Education, 90*, 453–467.

Goldstein, L.S., Lake, V.E. (2000). "Love, Love, and More Love for Children": Exploring Preservice Teachers' Understandings of Caring. *Teaching and Teacher Education*, 16, 861-872.

Hackling, M., Goodrum, D. & Rennie, L. (2001). The state of science in Australian secondary schools. *Australian Sciences Teachers' Journal, 47*(4), 12-17.

Hardy, D. C. (2003). Lab check, helping students write clear and concise laboratory reports. *The Science Teacher, 1,* 31-33.

Hofstein, A., Levi-Nahum, T. & Shore, R. (2001). Assessment of the learning environment of inquiry- type laboratories in high school chemistry. *Learning Environments Research, 4*, 193-207.
Hofstein, A., Shore, R., & Kipnis, M. (2004). Providing high school chemistry students with opportunities to develop learning skills in an inquiry-type laboratory: A case study. *International Journal of Science Education, 26*, 47-62.
Hofstein, A. & Naaman, R. M. (2007). The laboratory in science education: The state of the art. *Chemistry Education Research and Practice, 8*(2), 105-107.
Holt-Reynolds, D. (2000). What does the teacher do? Constructivist pedagogies and prospective teachers' beliefs about
the role of a teacher. *Teaching and Teacher Education, 16*(1), 21-32.
Holter, I.M. & Schwartz-Barcott, D. (1993). Action Research: What is it? How has it been used and how can it be used
in nursing? *Journal of Advanced Nursing*, 128, 298-304.
Jenkins, E.W. (2000). Science Education as a Field of Research, *Canadian Journal of Science, Mathematics & Technology Education*, *1*(1), 9-21.
Johnson, R. T. & Johnson, D. W. (1994). An overview of cooperative learning. In J. Thousand, A. Villa & A. Nevin
(Eds). Creativity and Collaborative Learning. Baltimore: Brookes Press.
Jones, M. E., Gott, R., & Jarman, R. (2000). Investigations as part of the key stage 4 science curriculum in Northern Ireland. *Evaluation and Research in Education, 14*(1), 23-37.
Karamustafaoğlu, O., Aydın, M. & Ozmen, H. (2005). The influence of the Physics activities supported with computer to the learning of students : An example of Simple Harmonic Activity. *The Turkish Online Journal of Educational Technology,* 4(4), 67-81.
Kearney1, M., Treagust, D.F., Yeo, S. & Zadnik, M.G. (2001). Student and Teacher Perceptions of the Use of Multimedia Supported Predict–Observe–Explain Tasks to Probe Understanding. *Research in Science Education 31*, 589-615.
Kipnis, M. & Hofstein, A. (2007). Inquiring the inquiry laboratory in high school. *Contributions from Science Education Research, 6*, 297-306.
Kocaküllah, M.S. & Kocaküllah, A. (2001). İlköğretim fen eğitiminde yapılan deneysel çalışmalar ile ilgili öğretmen görüşleri. Yeni Binyılın Başında Türkiyede Fen Bilimleri Eğitimi Sempozyumu, Maltepe Üniversitesi, 7-8 Eylül, İstanbul, 100-107.
Koyunlu Unlü, Z. & Dökme, İ. (2011). The Effect of Combining Analogy-Based Simulation and Laboratory Activities on Turkish Elementary School Students' Understanding of Simple Electric Cırcuits. *The Turkish Online Journal of Educational Technology, 10*(4), 320-329.
Lawson, A. E. (2000). Managing the inquiry classroom: Problems & solutions. *The American Biology Teacher, 62*(9), 641-648.
Lubben, R. & Ramsden, J. B. (1998). Assessing pre-university students through extended individual investigations: Teachers' and examiners' views. *International Journal of Science Education, 20*, 833-848.
Lunenberg, M. & Korthagen, F.A.J. (2003). Teacher educators and student-directed learning. *Teaching and Teacher Education, 19*, 29-44.
Metcall, K.K., Ronen-Hammer, M.A & Kahlich, P.A. (1996). Alternatives to Field-Based Experiences: The Comparative Effects of on-Campus Laboratories, *Teaching and Teacher Education*, 12(3), 271-283.
Morgil, İ., Ozyalçın Oskay, Ö., Yavuz, S. & Arda, S. (2003). The Factors that Affect Computer Assisted Education Implementations in the Chemistry Education and Comparison of Traditional and Computer Assisted Education Methods in REDOX Subject. *The Turkish Online Journal of Educational Technology*, *2*(4), 35-43.
Morrisey, J.T. (1981). An analysis of studies on changing the attitude of elementary student teachers towards science and science teaching. *Science Education, 44*, 24-35.
Moshe, S. & Pinchas, T. (1991). The expert case study model: An alternative approach to the development of teacher
education modules. *Journal of Education for Teaching, 17*(2), 165-180.
Ovens, P., (1999). Can Teachers Be Developed?, Journal of In-service Education, *25*(2), 275-306.
Ozmen, H. (2004). Fen öğretiminde öğrenme teorileri ve teknoloji destekli yapılandırmacı (constructivist) öğrenme. *The Turkish Online Journal of Educational Technology*, *3*(1), 100-111.
Palmer, D.H. (2002). Factors contributing to attitude exchange among preservice elementary teachers. *Science Education*, *86*(1), 122-141.
Prades, A., & Espinar, S. R. (2010). Laboratory assessment in chemistry: an analysis of the adequacy of the assessment process. *Assessment & Evaluation in Higher Education, 35*(4), 449- 461.
Roehrig, G. H., & Luft, J. A. (2004). Constraints experienced by beginning secondary science teachers in implementing scientific inquiry lessons. *International Journal of Science Education, 26*(1), 3-24.

Saka, A.Z., (2001). Determining Activities and Objectives for Physics Student Teachers in Teaching Practice. Science Institutes of Karadeniz Technical University, Unpublished Ph.D., Trabzon, Turkey.
Saka, M. (2002). Primary school students' opinions on science laboratory practice and laboratory conditions, V.National Science and Mathematics Education Congrees, METU, 16-18 September, Ankara.
Saka, A.Z. (2005). Öğretmen Adaylarına Öğretimde Yöntem Zenginliği Kazandırmak İçin Farklı Bir Yaklaşım, *Eurasian Journal of Educational Research*, *5*(19), 251-262.
Saka A.Z. (2004a). Fen öğretiminde kullanılan somutlaştırma araçları ve uygulanma düzeyleri. 6. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi, M.Ü. Atatürk Eğitim Fakültesi, 9-11 Eylül, İstanbul, 73.
Saka A.Z. (2004b). Improving professional skills of practitioners by constructing an effective approach in science teaching. *The Turkısh Online Journal of Educational Technology*, *3*(4), 28-37.
Saka, A. & Akdeniz, A.R. (2006). Genetik Konusunda Bilgisayar Destekli Materyal Geliştirilmesi ve 5E Modeline Göre Uygulanması. *The Turkish Online Journal of Educational Technology,5*(1), 129-141.
Saka, A.Z. (2007). Fen ve Teknoloji Öğretiminde Öğretmenlerin Rolleri ve Sorumlulukları. *İlköğretmen Dergisi*, Kök Yayıncılık, 7, 23-29.
Sarıbaş, D., Bayram, H.(2007). Kimya Öğretimine Yeni Bir Yaklaşım: Mikro Ölçekli Deneyler, EDU, 7, 2(2).
Shaw, R., (1995). Mentoring in Field, K.& Philpott, C.(2000). The impact of hosting student teachers on school effectiveness and school improvement. *Journal of in-service Education*, *26*(1), 115-137.
Singer, S., Hilton, M. & Schweingruber, H. (2005). Needing a new approach to science labs. *The Science Teacher, 72*(7), 10.
Skoumios, M. & Passalis, N. (2010). Chemistry Laboratory Activities: The Link between Practice and Theory. *The International Journal of Learning, 17*(6), 102-114.
Solomon, J. & Tresman, S. (1999). A model for continued professional development: Knowledge, belief and action. *Journal of In-service Education*, *25*(2), 307-319.
Springer, L., Stanne, M.E. & Donnovan, S.S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Rewiev of Educational Research*, *69*, 21-51.
Staer, H., Goodrum, D. & Hackling, M. (1998). High school laboratory work in Western Australia: Openness to inquiry. *Research in Science Education, 28*(2), 219-228.
Stein, M. & Wang, M. (1988). Teacher development and school improvement: The process of teacher change. *Teaching and Teacher Education, 4*, 171-187.
Talvitie, U., Peltokallio, L. & Mannisto, P. (2000). Student teachers' views about their relationships with university supervisors, cooperating teachers and peer student teachers. *Scandinavian Journal of Educational Research, 44*(1), 79-88.
Tasdelen K. (2004). Internet-based, interactive, virtual microcontroller laboratory desing for engineering education, Master of Thesis, University of Suleyman Demirel, Isparta,Turkey.
Tavşancıl, E. (2002). Tutumların Ölçülmesi ve SPSS İle Veri Analizi, Nobel Yayın Dağıtım, Ankara.
Teo, T. (2009). Examining The Relationship Between Student Teachers' Selfefficacy Beliefs And Their Intended Uses Of Technology For Teaching: A Structural Equation Modelling Approach. *The Turkish Online Journal of Educational Technology,8*(4), 7-16.
Thair, M. & Treagust, D.F. (1999). Teacher Training Methods in Indonesian Secondary Science: The Importance of Practical Work in Physics. *Journal of Research in Science Teaching*. *36*, 357-371.
Tillema, H.H. (2000). Belief change towards self-directed learning in student teachers: Immersion in practice or reflection on action: *Teaching and Teacher Education*, 16, 575-591.
Trumbul, D. J. & Kerr, P. (1993). University reseachers' inchoate critiques of science teaching: Implications for the content of preservice science teacher education. *Science Education*, *77*(3), 301-317.
Tsai, C-C. (2003). Taiwanese science students' and tachers' perceptions of the laboratory learning environments: Exploring epistemological gaps. *International Journal of Science Education*. *25*(7), 847-860.
Usun, S. (2006). Applications and Problems of Computer Assisted Education in Turkey. *The Turkish Online Journal of Educational Technology,5*(4), 11-16.
Veenman, S., Benthum, N., Bootsma, D., Dieren, J. & Kemp, N. (2002). Cooperative learning and teacher education. *Teaching and Teacher Education*, 18, 87-103.
Watson, R., Prieto, T. & Dillan, J.S. (1995). The effect of practical work on students' understanding of combustion. *Journal of Research in Science Teaching*. *32*, 487-502.
Wideen, M., Mayer-Smith, J. & Moon, B. (1998). A critical analysis of the research on learning to teach: Making a case for an ecological perspective on inquiry. *Review of Educational Research*, *68*(2), 130-178.
Wubbles, T. & Korthagen, F.A.J. (1990). The effects of a pre-service teacher education program for the preparation of reflective teachers. *Journal of Education for Teaching, 16*(1), 29-44.

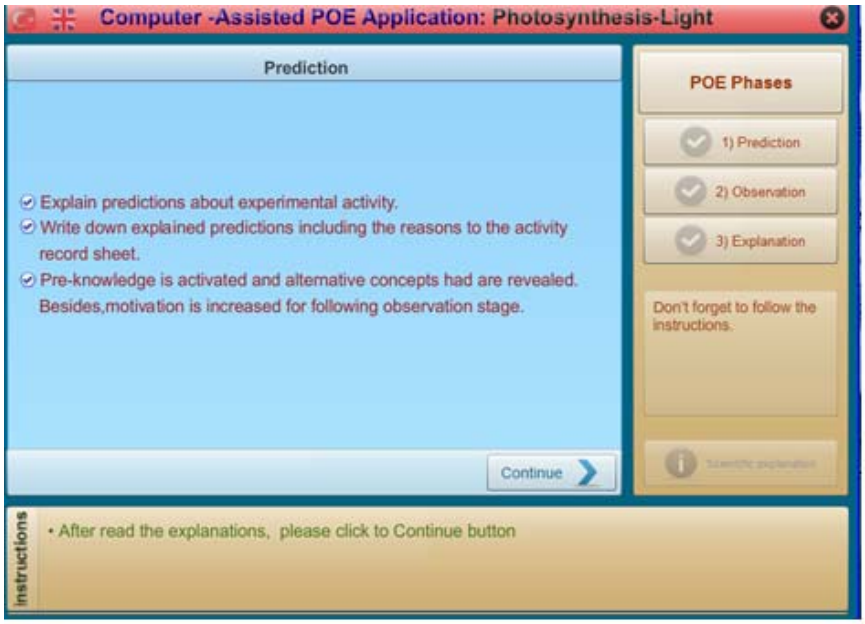
Yenice, N. (2003). Bilgisayar destekli fen bilgisi öğretiminin öğrencilerin fen ve bilgisayar tutumlarına etkisi. *The Turkish Online Journal of Educational Technology,2*(4), 79-85.

YÖK/Dünya Bankası Milli Eğitimi Geliştirme Projesi (1998). Fakülte Okul İşbirliği. Ankara, Hizmet Öncesi Öğretmen Eğitimi.

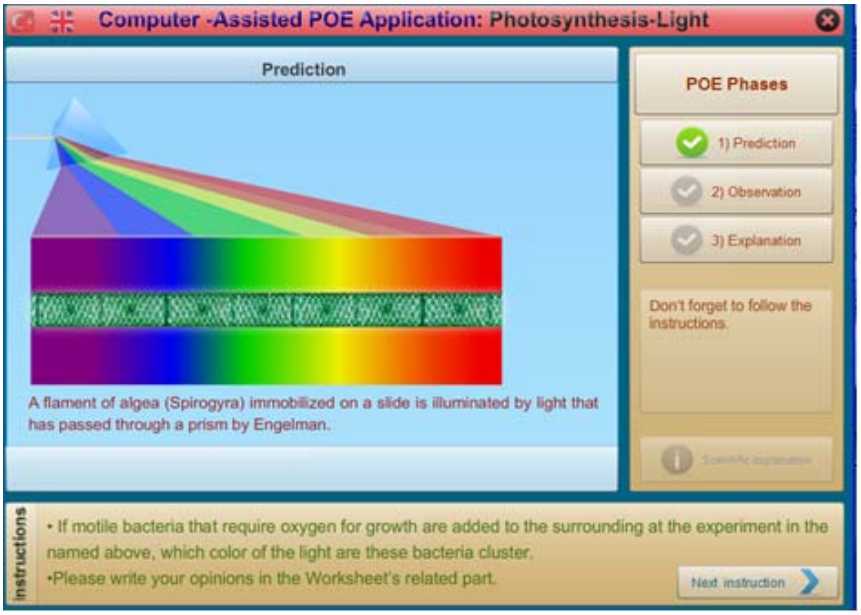
Appendix Figure 1. Screen image of main menu

Appendix Figure 2. Screen image when it is clicked the "POE Phases" button in the next step.

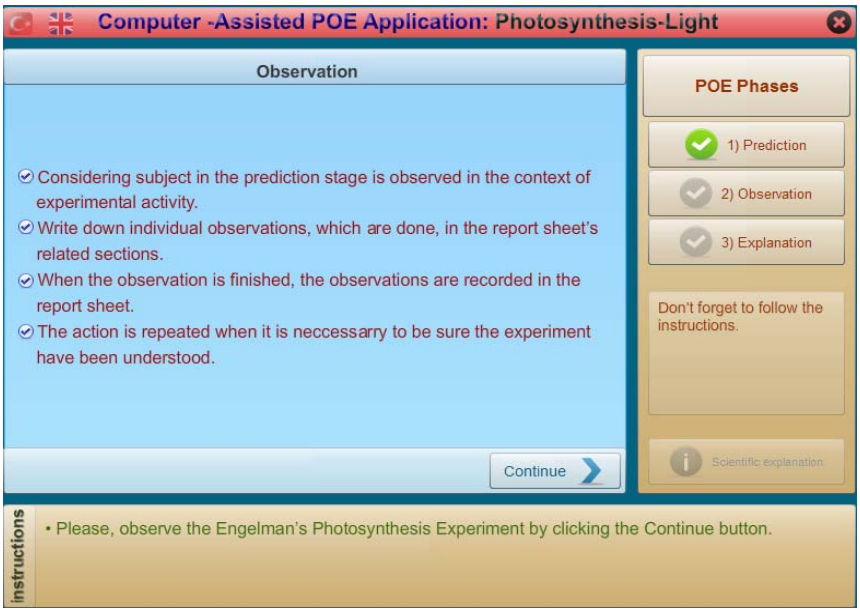
Appendix Figure 3. Screen image when it is clicked the “Prediction” button.



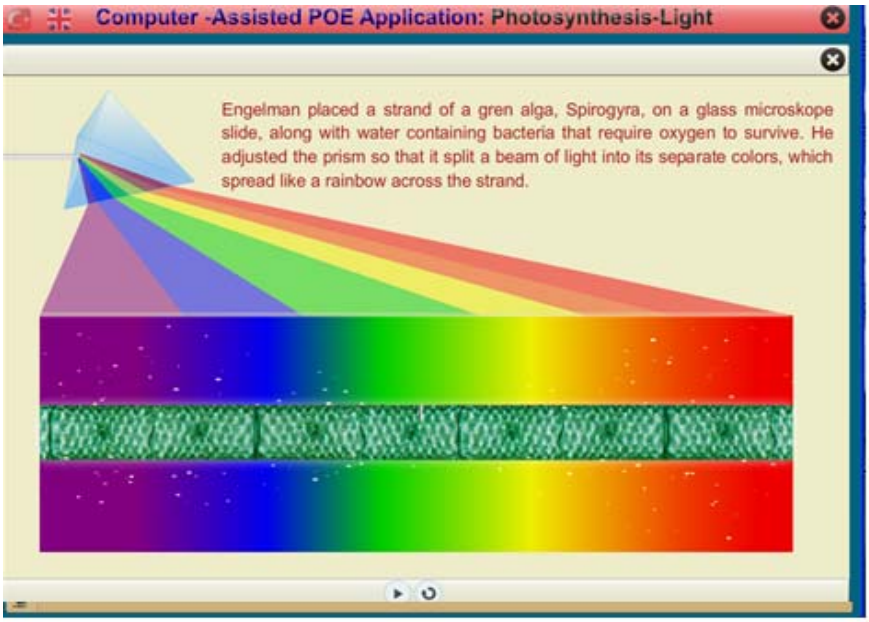
Appendix Figure 4. Screen image when it is clicked the “Continue” button in the Prediction phase.



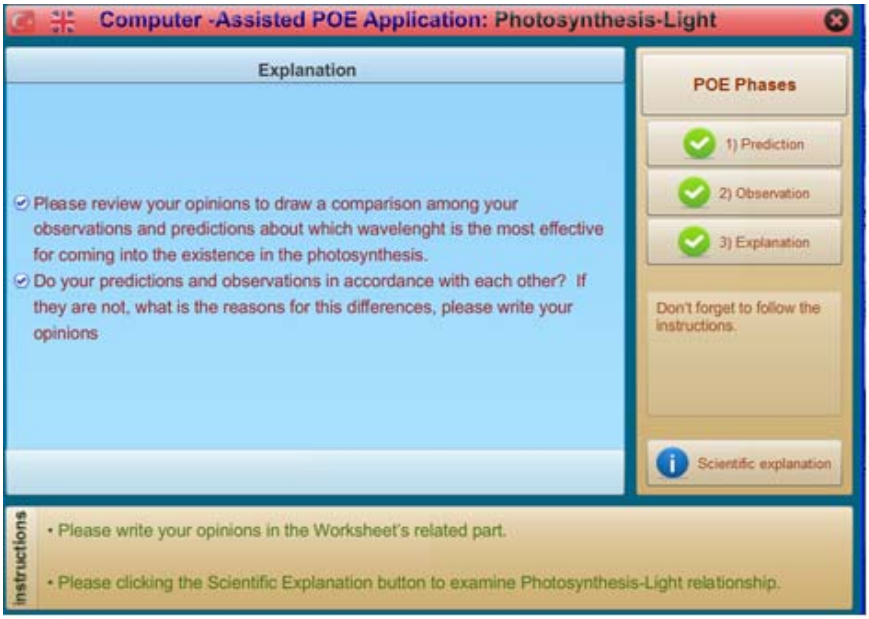
Appendix Figure 5. Screen image when it is clicked the “Observation” button.



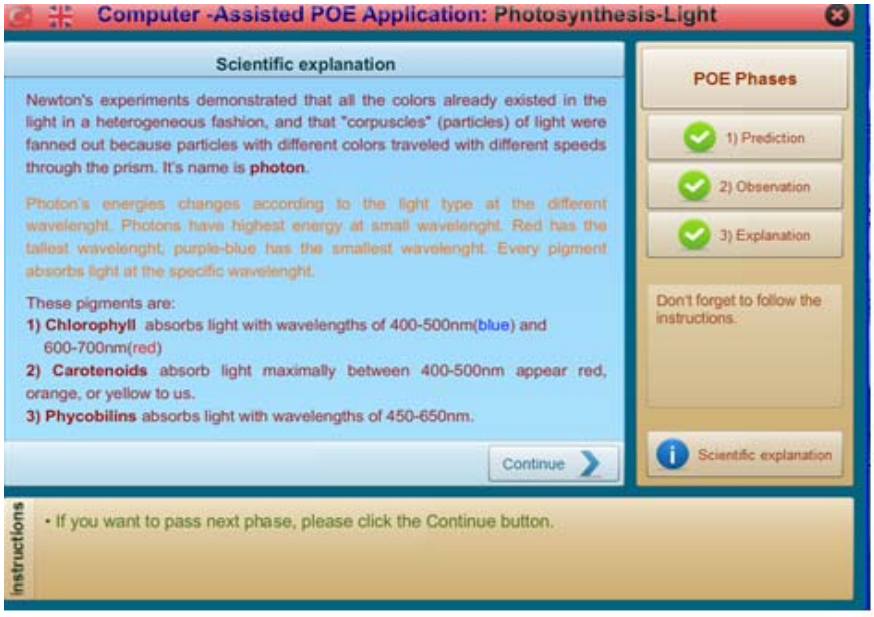
Appendix Figure 6. Screen image including the animation when it is clicked the “Continue” button in the Observation phase.



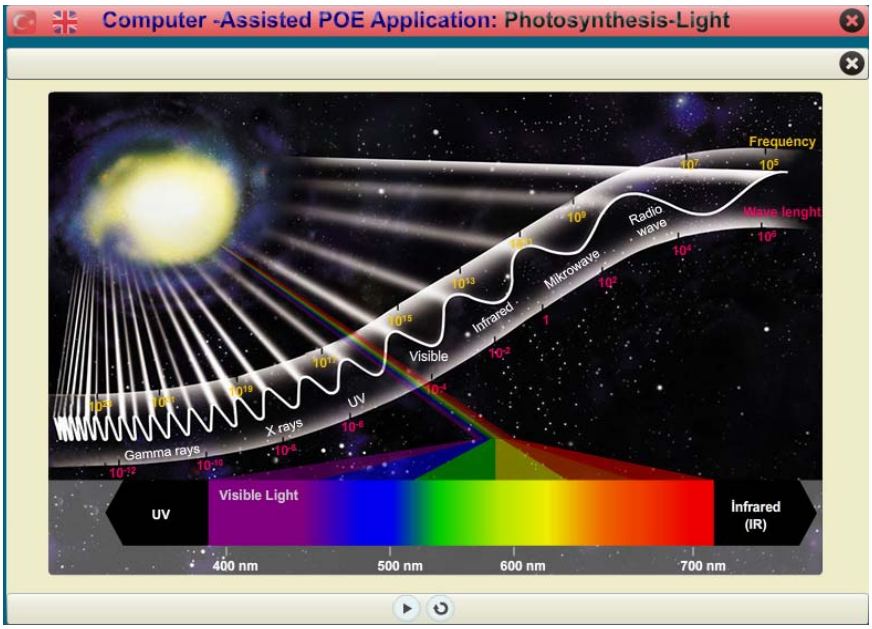
Appendix Figure 7. Demonstrative screen image requires to click the "Scientific explanation" button when it is clicked the "Explanation" button instructions are completed.



Appendix Figure 8. Screen image when it is clicked "Scientific explanation" button at the end of the POE application.



Appendix Figure 9. Screen image when it is clicked the “Continue” button in the “Scientific explanation” screen.



Appendix Table 1. Criterions for Student-teachers' presentations in the Science Teaching Laboratory Applications-I course

Criterions for Student-teachers' presentations in the Science Teaching Laboratory Applications-I course				
Each criteria has 5 point -----(D:Deficient (2 point), A: Acceptable (3 point), W:Well-trained (5 point))				
	Criterions	**D**	**A**	**W**
	Planning			
1	Introduction the laboratory approach which is used in the activity.			
2	Determination of approaches and techniques which are suitable for gains.			
3	Choosing suitable tools-equipment and material.			
4	Preperation an effective material.			
	Classroom management			
5	Suitable entrance into subject/to associate subject with everyday life.			
6	Relating subject with other courses.			
7	To attract attention and interest to subject.			
8	Ensuring continuity for interest and motivation to subject.			
	Teaching process			
9	Reflecting considered and suitable attitudes for class level when activity is prepared.			
10	Reflecting application phases of considered laboratory approach when activity is developed.			
11	Properly usage of selected approach when activity is developed.			
	Use of time effectively.			
12	Organizing activities for students' effective participation.			
13	Consideration of individual differences in teaching process.			
14	Usage of teaching tool-equipment and material for class level properly.			
15	Answering students' questions properly and sufficiently.			
16	Evaluating degree for obtaining of gains.			
	Communication			
17	Communication with students effectively.			
18	Giving obvious explanations and instructions.			
19	Effective usage of voice tone.			
20	Effective usage of verbal and body languages.			
	Total			
(D:Deficient, A: Acceptable, W:Well-trained) (C: Criteria)------ *C1-30 Point (W:15point, A: 20 point, G: 30 point); C2-40 Point(W:20point, A: 30 point, G:40 point); C3-30 Point (W:15point, A: 20 point, G: 30 point)*				
	Criterions	**D**	**A**	**W**
1	Level of writing the activity plan obviously and understandable (explaining plan's section; unit, class, gain, approach-method-technique, tool-equipment, aim, level of applied approach)			
2	Level of giving place to application' phases and principles of applied laboratory approach.			
3	Obeying the rules for writing report. (writing the principle of the applied approach on a italic style and passive basis, writing font (12), margins (2,5cm), general pattern, level of explanations to be plain and understandable)			
	Total			

Appendix Table 2. The standard deviation and mean values for student-teachers' gains in relation to the executed application in the pre and post application process of the developed approach. (***STLA-I: Science and Technology Laboratory Application-I; Sd: Standart deviation))***

Acquired behaviour	**Before STLA-I course**		**After STLA-I course**	
	Mean	**Sd**	**Mean**	**Sd**
Choosing efficient laboratory approach, method, and technique for the same gains.	**2.72**	**0.781**	**3.95**	**0.597**
Developing appropriate activities for different laboratory approaches, methods, and techniques considering the same gains.	**2.59**	**0.845**	**3.82**	**0.698**
Developing laboratory activity overcoming individual differences.	2.57	0.937	3.71	0.763
Using the same gains in different laboratory approaches, and observing whether the methods compensate each other's deficiencies	**2.52**	**0.916**	**3.92**	**0.752**
Developing the skills for scientific process	**2.55**	**0.796**	**3.81**	**0.650**
Explaining the advantages and limitations of the related approaches, methods, and techniques by observing the implementation of the activities intended for different laboratory approaches aiming at the same gains.	**2.69**	**1.035**	**4.14**	**0.743**
Gaining the skill to concretize abstract concepts by applying different laboratory approaches, methods, and techniques to the same gains.	2.72	0.882	3.93	0.742
Setting integrity between the theory and practice in the execution process of the course.	2.89	0.823	3.98	0.749
Reinforcing the fundamentals and application principles of different laboratory approaches, methods, and techniques.	**2.62**	**0.860**	**3.93**	**0.684**
Preparing and using testing apparatus based on different laboratory approaches, methods, and techniques by considering the same gains.	**2.71**	**0.849**	**4.01**	**0.701**
Developing and using simple course tools and equipment.	**2.87**	**0.953**	**4.11**	**0.741**
Using tone of voice efficiently in the execution of laboratory applications.	3.29	0.945	4.11	0.849
Achieving classroom management in implementation of laboratory applications.	3.28	0.890	4.12	0.788
In the execution of laboratory applications, observing the contribution of applying different approaches, methods, and techniques to set a qualified interaction with students.	**2.76**	**0.890**	**4.03**	**0.749**
Building effective learning-teaching environment in science and technology laboratory applications by considering different approaches, methods, and techniques.	**2.71**	**0.842**	**3.94**	**0.685**
Using time efficiently in the implementation of laboratory applications.	2.94	0.888	3.95	0.806
Building a democratic learning setting in the execution process of laboratory applications.	3.27	0.951	4.07	0.735
Developing the ability to explain.	3.20	0.920	4.13	0.720
Developing applying different teaching materials for laboratory applications.	2.98	0.910	4.07	0.686